Jl S. Afr. Bot. 49 (3): 251–259 (1983)

NOTES ON *TULBAGHIA*: 5. SCANNING ELECTRON MICROSCOPY OF SEED-COAT PATTERNS IN NINETEEN SPECIES*

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ABSTRACT

Scanning Electron Microscopy analysis of seed-coat patterns of nineteen species of *Tulbaghia* has revealed specific differences between them. The differences include variation in the size, form and sculpturing of the seed-coat surface cells. Each species possesses its own constant micro-morphological characteristics which can be used as an additional taxonomic marker.

UITTREKSEL

AANTEKENINGE OOR *TULBAGHIA*: 5. SKANDEER-ELEKTRONMIKROSKOOP ONDERSOEK VAN DIE PATRONE OP DIE SAADHUID VAN NEGENTIEN SOORTE

Skandeer-elektronmikroskoop ondersoek van saadhuid patrone van negentien *Tulbaghia*-soorte het spesifieke verskille aan die lig gebring. Die verskille sluit variasie in grootte, vorm van die oppervlakkige saadhuid-selle in. Elke soort het konstante mikro-morfologiese kenmerke wat as bykomende taksonomiese merker gebruik kan word.

Key Words: *Tulbaghia*, Scanning Electron Microscopy, testa micro-morphology.

INTRODUCTION

Most *Tulbaghia* species are notoriously difficult to identify as herbarium specimens (Vosa, 1975; Burbidge, 1978). Certain fine details of morphology, such as the fleshiness of the corona, are usually poorly preserved in dried material. However, ripe seeds are sometimes found on herbarium specimens and with this in mind, the present study concerns the use of Scanning Electron Microscopy of the seed-coat of *Tulbaghia* species. It includes all the species recognized by Vosa (1975) with the exception of *T. cameroni* Bak. and *T. rhodesica* Fries, for which no adequate seed samples were available.

MATERIAL AND METHODS

Ripe seed samples were collected from correctly identified species both on living plants and on herbarium specimens. Seeds from three to five

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* Continued from Jl S. Afr. Bot. **45**: 127–132 (1979); **46**: 109–114 (1980); **47**: 57–61 (1981); **48**: 241–244 (1982).

Accepted for publication 28th March, 1983.

plants, from different collections of each species, were sputter-coated with gold to about 20 nm thickness with a Polaron E-5000 coating unit, and examined in a Cambridge Stereoscan S-150 Scanning Electron Microscope. No fundamental differences were found in seed-coat patterning in different parts of the seed (Fig. 1).

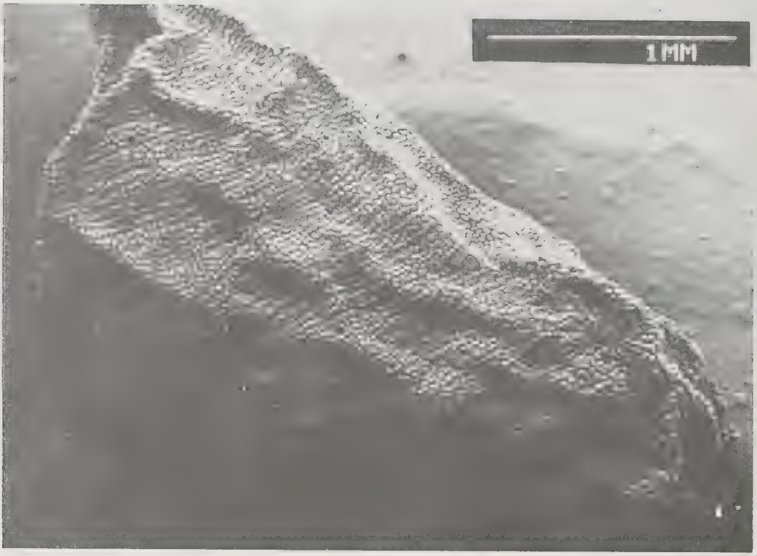

FIG. 1.
T. transvaalensis: the entire seed. Note uniformity of seed-coat pattern, × 140 ca.

RESULTS

The gross morphology of the seed of *Tulbaghia* is very uniform. All species have black on dark-brown coated seeds, which are typically elongated and usually very much creased and compressed into a wedge shape with a somewhat triangular section (Fig. 1).

Scanning Electron Microscopy reveals characteristic cell shapes and sculpturing of the outer cell wall of the testa.

No major differences in testa micro-morphology were observed between seeds from different collections of the same species.

Figures 2, 3, 4 and 5 show the differences between the species.

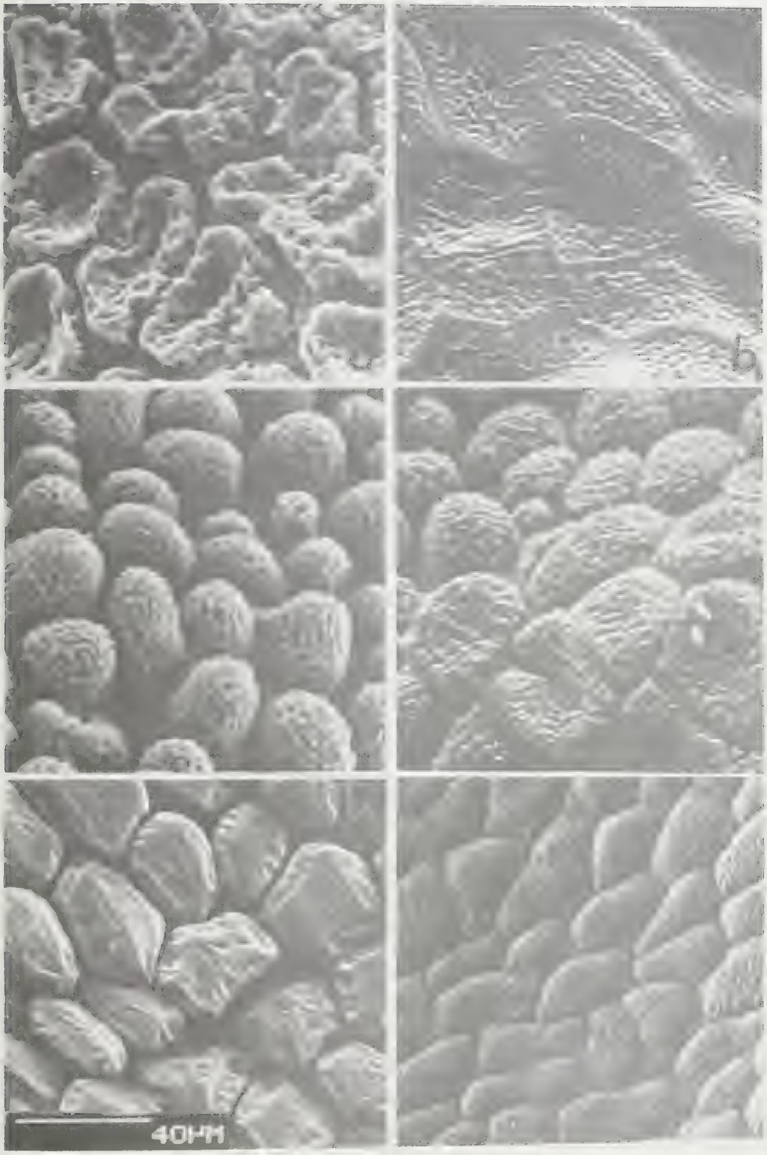

Fig. 2.
a. *T. capensis*; b. *T. alliacea*; c. *T. cernua*; d. *T. ludwigiana*; e. *T. dregeana*; f. *T. tenuior*, × 500 ca.

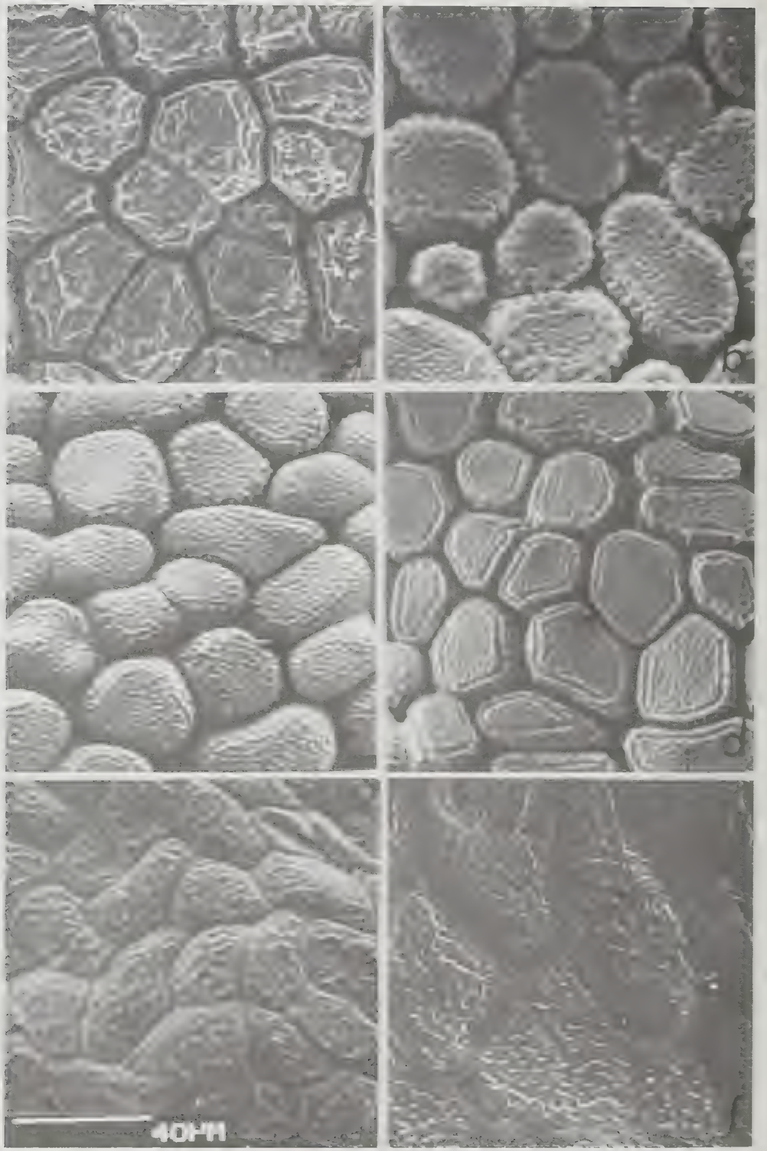

FIG. 3.
a. *T. nutans*; b. *T. macrocarpa*; c. *T. transvaalensis*; d. *T. acutiloba*; e. *T. simmleri*; f. *T. galpini*, × 500 ca.

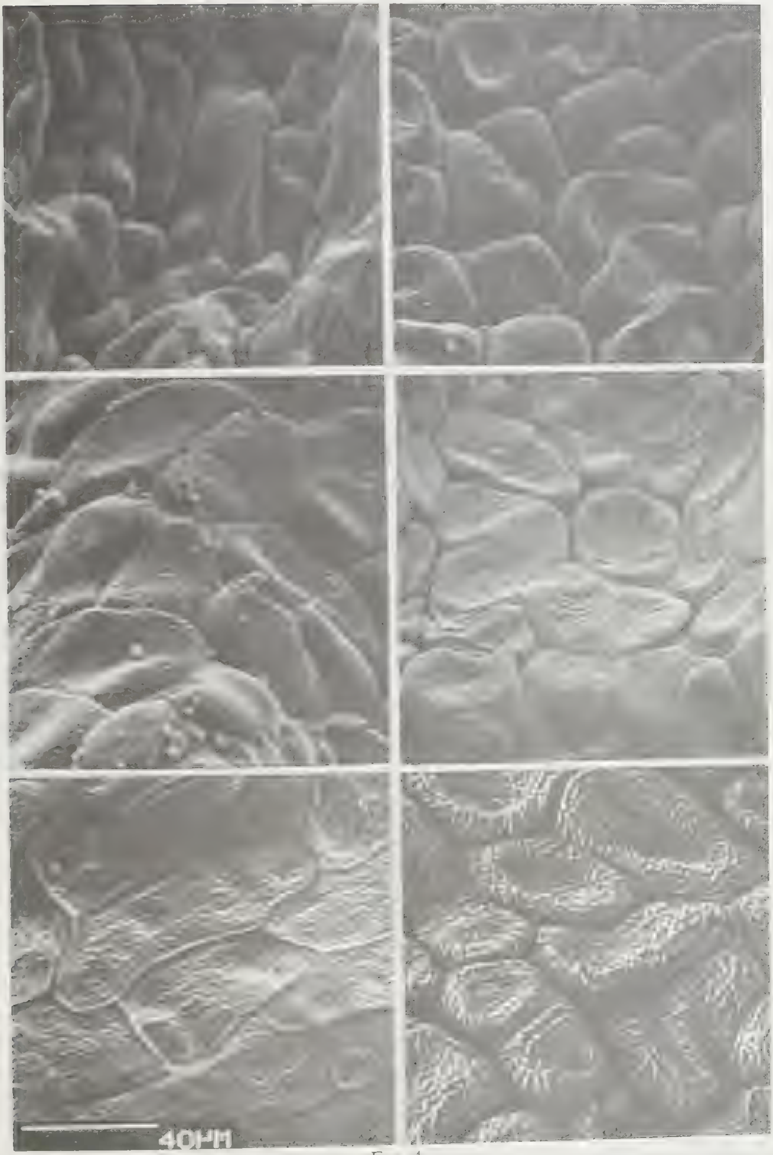

FIG. 4.

a. *T. leucantha* (2n = 2x = 12); b. *T. leucantha* (2n = 4x = 24); c. *T. natalensis*; d. *T. verdoornia*; e. *T. coddii*; f. *T. montana*, × 500 ca.

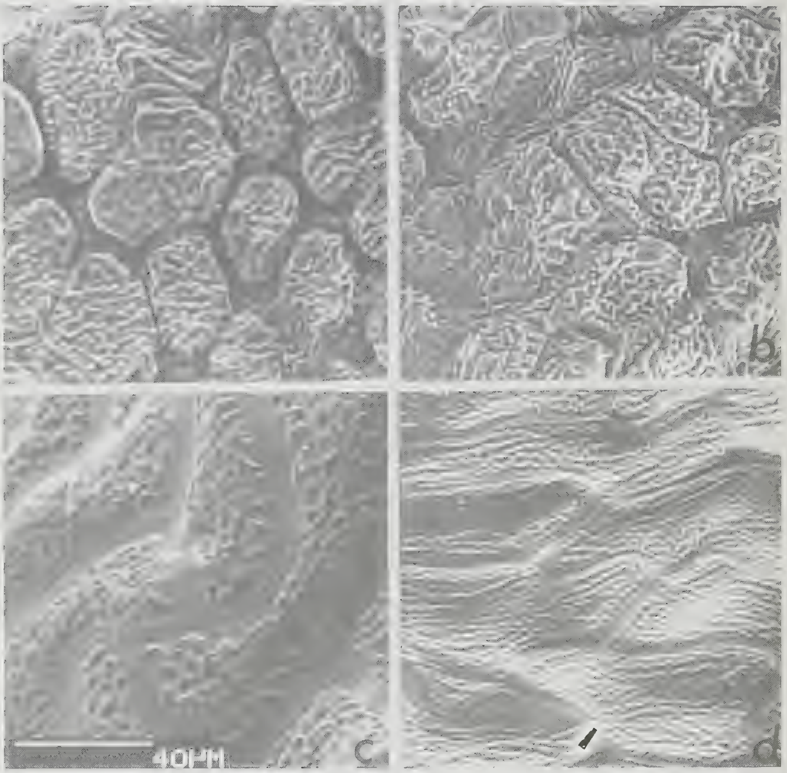

FIG. 5.
a. *T. violacea* from the eastern part of the range; b. *T. violacea* from the western part of the range; c. *T. violacea* var. *maritima*; d. *T. cominsii*, × 500 ca.

DESCRIPTIONS

Figure 2.

a. *T. capensis* L. (C. G. Vosa, 294/14, OXF): clear, distinctly raised cells, depressed and deeply pitted in the centre.

b. *T. alliacea* L.f. (C. G. Vosa, 61, OXF): flat appearance, cells with ribbon-like sutures and covered with an irregular netting of excrescences.

c. *T. cernua* Avé-Lall. (C. G. Vosa, 413/32, OXF and cultivated specimens): a clear papillate surface with somewhat sharp crowded ridges or crests.

d. *T. ludwigiana* Harv. (C. G. Vosa, 398/29, OXF): flattish cells with small excrescences and short ridges.

e. *T. dregeana* Kunth (C. G. Vosa, 62, OXF): somewhat polyhedric, almost smooth cells, with slightly creased upper surfaces.

f. *T. tenuior* Krause & Dinter (C. G.Vosa, 136 OXF): small polygonal cells with a crowded network of shallow ridges.

Figure 3.

a. *T. nutans* Vosa (C. G. Vosa, 536/55, OXF): straight-sided cells with a flat crinkled surface.

b. *T. macrocarpa* Vosa (C. G. Vosa, 132 OXF): round, well separated cells with a flat top covered with shallow ridges.

c. *T. transvaalensis* Vosa (C. G. Vosa, 486/49, OXF): plump, mostly flat-topped cells with minute excrescences and some longish furrows at the edges.

d. *T. acutiloba* Harv. (C. G. Vosa, 347/21, OXF and cultivated specimens): irregular, polygonal, flat-topped cells, with shallow pits ringed with furrow-like sculpturing at the edges.

e. *T. simmleri* Beauv. (C. G. Vosa, 487/50, OXF, and cultivated specimens): irregular shaped cells with well defined sutures and shallow mostly continuous ridges in waving lines.

f. *T. galpini* Schl. (C. G. Vosa, 60, OXF): largish, flat cells with well defined sutures and covered with irregularly shaped pits.

Figure 4.

a. *T. leucantha* Bak. (C. G. Vosa, 430/35, OXF, $2n = 2x = 12$): smooth looking cells with a minute vermiculate appearance.

b. *T. leucantha* Bak. (C. G. Vosa, 449/38, OXF, $2n = 4x = 24$): similar but somewhat larger and rounder cells than the diploid form.

c. *T. natalensis* Bak. (C. G. Vosa, 421/34): very similar to *T. leucantha* but flatter cells with slightly larger vermiculations.

d. *T. verdoornia* Vosa & Burbidge = *T. carnosa* Burbidge (C. G. Vosa, 1599, OXF): flattish, irregular cells with a minutely pitted surface.

e. *T. coddii* Vosa & Burbidge = *T. poetica* Burbidge (C. G. Vosa 496/52): flat appearance with mostly elongated cells covered with a network of more or less regularly spaced pits and raised, ribbon-like sutures.

f. *T. montana* Vosa (Bayliss, 7831, OXF): somewhat polygonal cells with definite boundaries and sharpish, regularly spaced excrescences.

Figure 5.

a. *T. violacea* Harv. (C. G. Vosa, 308/17, OXF): flat-topped cells with a crinkled and ridged surface and well defined depressed sutures. This collection is from the eastern part of the range.

b. *T. violacea* Harv. (C. G. Vosa, 371/23 OXF): as a. but usually larger more irregular cells. This collection is from the western part of the range of *T. violacea*, about 350 km SW of the a. collection.

c. *T. violacea* Harv. var. *maritima* Vosa (C. G. Vosa, 290/12): large, elongated cells, welded together by ribbon-like smooth sutures, strikingly different from *T. violacea sensu strictu.*

d. *T. cominsii* Vosa (C. G. Vosa, 1568, OXF): irregularly shaped, elongated cells, covered with a network of small excrescences. Cell sutures ribbon-like, well defined and smooth.

Except where indicated, the above descriptions refer to diploid plants. The hexaploid forms of *T. alliacea* and *T. capensis*, as well as the tetraploid form of *T. cernua* (Vosa, 1975), have been investigated and, as in the case of the diploid and tetraploid forms of *T. leucantha*, illustrated in Figure 4, a. and b., no fundamental differences, apart from the average cell size, were found.

Discussion

The differences between *T. alliacea* (Fig. 1, b.) and *T. cernua* (Fig. 1, c.), already discussed by Vosa (1981, pp. 58–61), are also evident in their testa micro-morphology. The flat, well sutured cells of *T. alliacea* are in fact very different from the domed, somewhat bell-shaped cells of *T. cernua.*

The recognized morphological and cytological relationship between *T. leucantha* (Fig. 3, a. and b.), *T. verdoornia* (Fig. 3, d.) and *T. natalensis* (Fig. 3, c.), is confirmed by the similarity of the seed-coat patterns. The further two species in their group (Group 5, Vosa, 1975, pp. 57–60), *T. galpini* (Fig. 2, f.) and *T. coddii* (Fig. 3, e.) possess a testa micro-morphology which is distinct from one another as well as from the other species.

T. alliacea, T. galpini, T. coddii, T. violacea var. *maritima* and *T. cominsii*, though well distinct from each other, share a characteristic testa with a flat-cell appearance and well defined ribbon-like sutures, quite unlike other *Tulbaghia* species.

The existence of such similarity may have an ecological significance in relation to seed dispersal and germination. In this context it is interesting to note that the above five species, with the exception of *T. galpini*, at least in the southern area of its range, normally inhabit humid places which are usually periodically flooded. The possession of close cell sutures may play a part in delaying water uptake, probably permitting longer distance seed dispersal, which, in *Tulbaghia*, is effected by the swaying fruiting stems when the loculicidal capsule opens.

The S.E.M. of the testa micro-morphology of nineteen species of *Tulbaghia* has shown certain unique and species specific features. Apart from the ecological significance, these unique features, as well as the similarities, can be regarded as a useful addition to the more usual characters used in taxonomic identification in *Tulbaghia*.

ACKNOWLEDGEMENTS

I wish to thank Lindsay Helsby, Gavin Wakley and David Kerr for their technical assistance and advice.

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